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(71) Applicants  
Roquette Freres (France)  
62136 Lestrum, France

(72) Inventors  
Michel Huchette  
Monique Dumont  
Denis Cuvelier  
Francois Roumet

(74) Agent and/or Address for Service  
Elkington and Fife, High Holborn House, 52/54  
High Holborn, London WC1V 6SH

**(54) Method and agent for the optimisation of the assimilation of the feed ration by fattening ruminants**

(57) A method of optimisation of the assimilation of the feed ration in fattening ruminants, comprising possibly a maintenance period, consists in making the ruminant ingest, at the same time as the normal food ration, an effective amount of sorbitol. Foodstuffs for growing cattle can comprise an effective amount of sorbitol for example between 0.1 to 2.0% by weight.

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## SPECIFICATION

**Method and agent for the optimisation of the assimilation of the food ration by growing cattle**

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The invention relates to a method and to an agent for the optimisation of the assimilation of the food ration by growing cattle, that is to say by ruminants intended for meat production.

10 The invention also relates to the optimisation of the assimilation of the food ration of ruminants intended for meat production when the said ruminants are in a maintenance period, particularly the winter season.

The invention also relates, as new industrial products, to compositions and foodstuff forms intended for said animals and incorporating this agent.

The optimisation of the assimilation of the food ration — that is to say the obtaining of an increase in weight as high and rapid as possible for a given ration

20 — is wished for by reason of its effects from the economic point of view whatever the type of bred cattle concerned.

It has a particular importance in the case of ruminants — particularly oxen, bull-calves, cows,

25 heifers — intended for fattening, that is to say the production of meat, by reason of the well known fact that a part only of the food is used by these animals for their growth, this by reason of the nature of foodstuffs currently distributed, which are only partly digested, as well as by reason of their particular anatomy essentially adapted to a herbivorous diet.

It has already been proposed, to overcome this drawback, to protect, for example by tanning or by encapsulation, at least certain of the constituent elements of the food ration to avoid them being too considerably degraded in the rumen and so that they can reach the duodenum.

It has also been proposed, in a field different from that of the fastening of ruminants, namely that of increasing the blood sugar content and the milk yield of ruminants (French Patent No. 2,344,233), to use xylitol mother liquors as additives for foodstuffs for milking cows; it is recalled in this respect that the alimentary diet of the milch-cow is very different from 45 that of growing cattle both in the different ratio of digestible protein to non-digestible protein, and by the addition of carbohydrates. The Xylitol mother liquors to which recourse is had, comprise with respect to the dry matter from 5% to 25% of xylitol, from 20% to 35% of arabitol and 10% to 25% of mannitol, 5% to 15% of sorbitol, from 5% to 10% of dulcitol and from 5% to 10% of rhamnitol.

According to the explanation given, the effect on the milk production obtained by the addition of xylitol mother liquors to the forage is due to the fact that polyalcohols of a glucidic character have an excellent resistance to degradation in the rumen and that they would thus be capable of reaching the intestine before a considerable degradation occurs. The *in vitro* study 60 of the resistance to degradation of the different polyols concerned has led to the observation that pentitols (xylitol and arabitol) offer by far the best resistance, whereas sorbitol is degraded much more rapidly.

65 The fact that the xylitol mother liquors can be

considered as additive without danger and useful for the feeding of milch-cows, results also from the study, published in "NUTRITION REPORTS INTERNATIONAL", June 1981, vol. 23, n°6, p. 1077-1087.

70 A more recent work published in "J. Sc. Food Agr." 1984, vol. 35, p. 21-28, relates to trials on sheep and shows also that sorbitol and mannitol disappear rapidly, especially by incubation with adapted microorganisms, and cannot be detected in the digestive contents of the duodenum, thus confirming that the effects observed from the point of view of the increase in the production of milk by administration of xylitol mother liquors to milking cows, are due exclusively to pentitols like xylitol and arabitol.

80 Taking into consideration the reality of this very rapid degradation of sorbitol in the rumen of ruminants, of which fact the immediate consequence is that this hexitol does not reach the duodenum, the man skilled in the art would wave aside any possibility of action on the part of the sorbitol on phenomena accompanying digestion and assimilation of foodstuffs in the case of growing cattle.

And it is

— neither the knowledge of French patent N° 79 01697, which recommends the use of sorbitol, as a cholagogic agent, in the preruminant calf, which could change anything at all in this respect in the mind of the man skilled in the art since the preruminant calf has a monogastric animal physiology,

95 — nor the fact that sorbitol has already been used to complement certain vitamin solutions or certain curative preparations, the administration then being carried out either with very low doses, or with larger doses but punctually and episodically and for a limited time, in the case of digestive troubles of certain animals.

Under these conditions, the merit of Applicants is all the greater in having found that, quite surprisingly and unexpectedly, the addition of a small amount of sorbitol to feedstuffs for growing cattle, that is to say for meat production, enabled the assimilation of the food ration for these animals to be optimised, in other words

— to increase significantly the average daily gain in weight and, simultaneously,

110 — to improve the consumption index which is illustrated by the ratio "amount of foodstuff ingested/ amount of meat produced".

It follows that the method according to the invention 115 of optimising assimilation of the food ration in growing cattle comprising possibly a maintenance period, is characterised by the fact that the ruminants are made to ingest or eat, at the same time as the normal foodstuff ration, an effective amount of sorbitol.

It follows also that the agent for the optimisation of the assimilation of the feedstuff ration in the growing cattle is characterised by the fact that it is essentially constituted by sorbitol of which is intended consequently the application to the abovesaid process of optimisation.

It follows finally that the foodstuff for growing cattle according to the invention is characterised by the fact that it comprises an effective amount of the abovesaid agent, constituted essentially by sorbitol.

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Whichever that of the various aspects of the invention defined above which is retained, the sorbitol employed can be in the form of a powder or of a solution, or pure, or in the form of a hydrogenated starch hydrolysate of which it represents the principal constituent; preferably, the sorbitol is, in the latter case, present in the proportion of at least 71% by weight, expressed on the dry matter content of the hydrolysate.

Advantageously, the amount of sorbitol employed is at least 10 g per day, the practical limit, not imperative but imposed by economic considerations, being about 200 g per day.

More precisely, the abovesaid lower limit is about 20 g and the upper limit about 129 g per day, an amount frequently selected being 80 g per day.

In an advantageous embodiment of the invention, the industrial product constituted by the foodstuff for the ruminant, comprises a proportion of about 0.1 to about 2% by weight, preferably from about 0.3% to about 1.2% of sorbitol, these percentages being expressed in dry matter to dry matter.

The use of sorbitol in the feeding of ruminants enables, as illustrated by the examples, the average daily gain in weight of the animals to be very substantially increased; what is important, is that this average daily gain is not obtained by a larger consumption of foodstuffs since the consumption index is not higher but, on the contrary, even generally lower.

The mechanism of action of the sorbitol has not yet been explained.

Tests made within the scope of the invention have shown besides, that the optimisation effect exerted by sorbitol is particularly marked with foodstuffs having contents of total nitrogenous materials which are low or average, that is to say less than 15% and, in practice, comprised between about 9% and about 13%, these percentages being expressed in  $N \times 6.25$  with respect to dry matter.

A preferred embodiment of the method according to the invention consists therefore of causing the ruminant to ingest an effective amount of sorbitol at the same time as a foodstuff having a content of  $N \times 6.25$  less than 15% and, preferably, comprised between 9% and 13% by weight.

The administration of the sorbitol may be done by mixing with other constituents of the food ration of the ruminant at meal times; it is possible to provide ready-to-use mixes, that is to say feed stuffs directly useable and comprising, besides the sorbitol, at least certain of, if not all the constituents of the food ration.

The invention will be still better understood by means of the examples which follow and which comprise the description of advantageous embodiments.

#### EXAMPLE 1

By this example, it is shown that sorbitol is very rapidly degraded by the microorganisms of the rumen and hence cannot reach the duodenum.

It relates to an in vitro test, carried out according to the technique developed by I.N.R.A. of Theix and in which various amounts of sorbitol are placed to incubate for six hours at 39°C in a medium not limiting in ammoniacal nitrogen and in the presence of a large amount of contents and of juice of the rumen. Samplings of the juice and of the contents of the rumen are made before feeding on a heifer provided with a fistula of the rumen and receiving a constant foodstuff regimen free from sorbitol.

The composition of the above-said medium is as follows:

— 400 ml of artificial saliva whose composition is as follows:

75	. bicarbonate	9.24 g
	. disodium phosphate	7.12 g
	. K chloride	0.45 g
	. Ca chloride	0.055 g
	. Mg chloride	0.047 g
80	. distilled water q.s.p.	1 liter,
	— 200 ml of rumen juice,	
	— 200 g of rumen contents,	
	— 15 g of potato pulp and	
	— 0.250 g of urea.	

85 In three Erlenmeyer flasks, each containing a liter of this medium, are added respectively 0.40, 0.80 and 1.60 g of sorbitol.

The residual sorbitol is measured specifically in four samplings carried out respectively after 1 h, 2 h 30 minutes, 4 h and 6 h of incubation.

The results obtained are collected in Table I.

TABLE I

	Amount (in g) of residual sorbitol in the sample taken at "t"				
	t= 0h	t= 1h	t= 2h 30 mn	t= 4h	t= 6h
Erlenmeyer n°1	0.40	0.25	0.02	0	0
Erlenmeyer n°2	0.80	0.45	0.06	0	0
Erlenmeyer n°3	1.60	1.05	0.72	0.40	0

After 2 hours and a half of incubation, the sorbitol is hence completely degraded for the doses of 0.40 and 0.80 g; with a dose of 1.60 g, it is completely degraded at the end of six hours.

#### EXAMPLE 2

To confirm the results presented in Example 1, the fate of the sorbitol in the rumen was studied in the Laboratory of Ruminant Digestion of the I.N.R.A. at

100 Theix on three sheep each bearing two canulae, one to the rumen and the other to the duodenum.

40 g of sorbitol was introduced in a single dose to the rumen through the canula of the rumen before the morning feeding.

105 Samplings of juice and of contents of the rumen were carried out after 15 minutes, 30 minutes, 90 minutes, 2 hours, 3 hours, 4 hours, 6 hours and 8

hours.

At the same moments, samples were taken at the level of the duodenum.

The determination of the sorbitol in these samples showed:

- 5 — that the sorbitol disappeared very rapidly from the rumen, the ratio of residual sorbitol being below the detection threshold 90 minutes after administration.
- 10 — that the amount of sorbitol, which arrives in the small intestine, is very low, that is to say of the order of 2% of the amount administered, despite the size of

this amount administered in a single dose.

### EXAMPLE 3

- 15 Two *in vivo* tests were carried out at the Laboratory of Meat Production of I.N.R.A. at Thix on bull-calves aged eight months; two types of feed stuffs were tried, the first having corn husks as a base, the other having corn seed or grain as a base.

- 20 a) *Results obtained with the foodstuff based on corn husks*

Six feeding diets whose composition is indicated in Table II, were administered to six groups of five bull-calves.

TABLE II  
COMPOSITION OF FOOD-STUFF DIETS

Constituent (Z)	Regime n° 1	Regime n° 2	Regime n° 3	Regime n° 4	Regime n° 5	Regime n° 6
Corn husks	79.1	79.7	78.2	78.8	77.3	77.9
Starch	13.1	13.2	13.0	13.1	12.8	12.9
Corn grain	5.5	5.5	5.4	5.4	5.4	5.4
Vitaminised mineral condiment	1.6	1.6	1.6	1.6	1.6	1.6
Urea	0	0	1.1	1.1	2.2	2.2
Sorbitol	0.70	0	0.70	0	0.70	0
Total nitrogenous materials (g of N x 6.25 per kg)	90.75	90.4	121.3	121.9	152.0	152.6

- 25 The results obtained with the various food stuff diets or regimens are collected in Table III.

TABLE III

Identification of the magnitude contemplated	Duration	Regimen					
		n°1	n°2	n°3	n°4	n°5	n°6
Accumulated average daily gain (in g)	56 days	1025	888	1263	1221	1096	1236
	124 days	1162	1030	1130	1200	1120	1230
	142 days	1137	1042	1193	1103	1140	1245
Gain in weight (in g) Forage units ingested	56 days	145	1117	187	170	161	174
	124 days	153	130	157	153	150	161

- 30 On examining the values collected in Table III, it is observed that the sorbitol improved the average daily gain and that this increase is not due to an increase in the amount of ingested foodstuff. In fact, the gain in weight per unit energy is improved when sorbitol is added.

On the other hand, for this type of foodstuff, the

sorbitol does not seem to have any effect when the content of nitrogenous material is higher than 15%.

- 35 b) *Foodstuff regimen based on corn grain*

The composition of the foodstuff diets is indicated in Table IV. Each regimen is administered to a group of bull-calves.

TABLE IV  
COMPOSITION OF FOODSTUFFS

Constituent (Z)	Regime n° 1	Regime n° 2	Regime n° 3	Regime n° 4	Regime n° 5	Regime n° 6
Corn grain	78.9	77.4	75.9	76.5	75.2	75.8
Starch	6.7	6.8	6.6	6.7	6.5	6.6
Corn husks	12.4	12.6	12.4	12.5	12.1	12.2
Vitaminised mineral condiment	1.6	1.6	1.6	1.6	1.6	1.6
Urea	0	0	1.1	1.1	2.2	2.2
Sorbitol	0.80	0	0.80	0	0.80	0
Total nitrogenous material (g of N x 6.25 per kg)	93.4	94.1	124.0	125.0	154.6	155.3

The results obtained are collected in Table V.

TABLE V

Identification of the magnitude considered	Duration	Regimen					
		n°1	n°2	n°3	n°4	n°5	n°6
Accumulated average daily gain (in g)	56 days	888	821	1107	1023	1236	1264
	124 days	1000	790	1270	1130	1340	1390
	142 days	970	818	1232	1151	1352	1392
Gain in weight (in g)	56 days	135	88	165	144	183	178
Forage units ingested	124 days	132	102	168	146	177	181

It is here again observed that addition of sorbitol considerably improved the average daily gain and foodstuff effectiveness for animals receiving foodstuffs whose content is  $N \times 6.25$  is about 9% to 12.5%.  
 5 CLAIMS

1. A method for the optimisation of the assimilation of the feed ration in growing cattle comprising possibly a maintenance period, characterised by the fact that the ruminant is made to ingest, at the same time as the normal foodstuff ration, an effective amount of sorbitol.
- 10 2. A method as claimed in claim 1 characterised by the fact that the amount of sorbitol employed is at least 10 g per day.
3. A method as claimed in claim 1 or claim 2 characterised in that the upper limit of the amount of sorbitol employed is about 200 g per day.
4. A method as claimed in any of claims 1 to 3 characterised in that the amount of sorbitol employed is from about 20 to about 120 g per day.
5. A method as claimed in claim 4 in which the amount of sorbitol is about 80 g per day.
6. A method as claimed in claim 1 substantially as herein described.
7. Optimisation agent for the assimilation of the feed ration in growing cattle, characterised by the fact that it is essentially constituted by sorbitol.
8. Use of sorbitol as an optimisation agent for the assimilation of the feed ration in growing cattle.
- 30 9. Foodstuff for growing cattle characterised by the fact that it comprises an effective amount of the agent according to claim 7.
10. Foodstuff for growing cattle, characterised in that it contains an amount of sorbitol of between about 0.1 and about 2% by weight.
- 35 11. A foodstuff as claimed in claim 10 in which the amount of sorbitol is from about 0.3 to about 1.2% by weight.
- 40 12. A foodstuff as claimed in claims 10 or claim 11 characterised by the fact that it has a total nitrogenous material content of less than 15% and a sorbitol content between about 0.1% and about 2% by weight.
- 45 13. A foodstuff as claimed in claim 12 in which the total nitrogenous material content is from about 9% to about 13% by weight.
14. A foodstuff as claimed in claim 10 substantially as herein described with reference to the Examples.